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BOSTON SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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FUEL AND POWER PROBLEMS.

SOME PROBLEMS OF THE COAL INDUSTRY.

BY GEORGE B. HARRINGTON.*

(Presented before The Affiliated Technical Societies of Boston, March 28, 1923.)

YOUR chairman has asked me to tell you what I can about the problems and future outlook of the coal industry.

It is an honor to address such a gathering as this, but it is also a difficult and responsible task to attempt to say something new and worth while on this complicated and much discussed subject to a group of men already well versed in economic and industrial affairs.

It would be comparatively simple for me to describe to you some particular branch of the subject — such as the methods of mining; the character and distribution of coal deposits; the progress that is being made towards a more economical use of coal; an explanation of the recent coal strikes; the transportation and distribution difficulties, or any of several other broad divisions of the general topic. To attempt to cover all of these correlated subjects in one brief talk would be unsatisfactory, so I have decided simply to try to give you, if I can, a picture of the present situation in the industry and of some of the chief problems with which it and the country are immediately faced.

* President, Chicago, Wilmington and Franklin Coal Company, Chicago, Ill.

As you know, there is under way at this time, under an Act of Congress, a very thorough and painstaking effort to gather the exact facts about coal in this country. The United States Coal Commission has just recently received an additional \$400 000 appropriation and an extension of time in which to report, and has at work today, besides its own membership, a staff of more than two hundred people — in addition to which there are countless persons connected with various branches of the coal business, and with the railroads and other groups of consumers, who are devoting all or part of their time to this work. The Commission plans in the near future to bring out, through the presentation of briefs and public hearings, all of the basic facts, troubles or disputes, giving all concerned — operators, mine workers and coal buyers — an equal chance to state their cases and opinions.

I do not wish to take to myself, or to anticipate at this time, a presentation of an operator's view of these trying questions. In fact, it was my wish simply to quote recognized impartial authorities as to statistical facts and to present to you both sides of questions in controversy or open to debate. But I must confess that after reading numerous reports and articles, and several books and enumerable pamphlets, I felt somewhat like a small boy at a big three-ring circus, — unable to take it all in at one sitting. I will do the best I can in the time available, trying to be as fair and unbiased as is possible for one who has had experiences tending to form strong convictions in certain directions.

At this point I would like to say, however, that I believe that a very large majority of those intimately connected with, or interested in coal, welcome the present investigations, are coöperating with the Commission, and wish that the findings be made as thorough and conclusive as possible. Most of these with whom I have talked seem to feel, as I do, that President Harding has made a sincere effort to select for this difficult and important task an able and fair-minded group of men, well balanced as to experience and of known ways of thinking, and are assuming that only good to the common welfare can come from an unbiased study of this perplexed problem.

I need not tell you of the tremendous importance of abundant and cheap coal to this or any other nation, or of the great part which our exceptionally bountiful coal resources have played in the life of this country to date. Practically within a century we have developed a coal industry employing three-quarters of a million men and more than two and one-third billions of capital — producing nearly half the total annual coal output of the world. The development of our coal deposits, as of our national consumption of coal, has been extremely rapid.

Dr. George Otis Smith, for long director of the Geological Survey, gives the following statistical data in a most interesting article in the *Atlantic Monthly* of last October — probable world's supply of coal, five million million tons, not including lignite — half of this being in North America. He estimates the per capita coal reserve, for every man, woman and child, in the United States 23 000 tons; Great Britain 5 000 tons; Germany 4 000 tons; Belgium 1 500 tons; France more than 800 tons; Spain less than 400 tons; Japan 150 tons. Dr. Smith estimates the present annual consumption in the United States at six tons per capita, (pointing out that this was only one ton per capita fifty years ago), and believes that less than one-half of this coal is used for heating and cooking, the balance rendering a large indirect personal service in enumerable ways.

Except in the case of anthracite, which all comes from one limited area of less than five hundred square miles in Pennsylvania and may be considered as a luxury fuel, the exhaustion of which at present rate of output is definitely in sight, the United States has a very long-lived and wonderfully generous coal reserve — underlying some 500 000 sq. mi. of territory and fairly well distributed throughout the country. Probably not over one-half of one per cent. of our bituminous coal has been mined, but we have worked on the best and most accessible veins, and some authorities think that most of the high rank deposits will be gone within fifty years.

Broadly speaking, I think it is fair to say that America has been spendthrift and wasteful in its whole relation to coal; wasteful in mining; wasteful in transportation effort; inefficient, taken as a whole, in buying and selling methods; and most wasteful

and inefficient in final utilization, which saves for useful purposes on the average only a fair percentage of the heat or energy values and throws away in smoke all but a very small percentage of the extremely serviceable and needed commodity content, savable as gas, ammonium sulphate, benzol, coal tar, and their many derivatives.

I do not mean by this to imply that those responsible for the coal industry, either the owners or operators, or the mine workers, are, as a class, below the average of intelligence ability or patriotism, or that coal consumers are wilfully negligent or careless. The production and use of coal has grown so very rapidly and been brought about by so many people, and under such changing economic and political conditions — unrestrained almost entirely by a necessity as yet for the economies that will all appear as necessity impels, — that I think it is more fair to say that what has occurred has been largely the natural outcome of current conditions.

An exceptionally interesting book by Messrs. Chester G. Gilbert and Joseph E. Pogue ("America's Power Resources" — Century Company, 1921) goes into the statistics and argument of the coal situation more thoroughly than it is possible for me to attempt. Those of you who wish to go into the subject more deeply will find this book worth reading.

The coal industry has functioned very badly since the war, on two occasions threatening to tie up the whole country during the big strikes of 1919 and 1922. Before and following these strikes coal prices and coal supply were most unsatisfactory, and in between them the industry suffered partial stagnation from over capacity and over-manning. At the present time most authorities conceded an excess mine capacity of 25 to 50 per cent. and an over-manning of the industry by not less than one hundred thousand to one hundred and fifty thousand men.

About two-thirds of the country's mine-workers, including all in the anthracite field, belong to the United Mine Workers of America; the remaining ones — chiefly in West Virginia and Central Pennsylvania — are non-union. The United Mine Workers of America has shown itself to be one of the most powerful labor unions in the country — if not in the world — being

able, at the will of its officers, to place and hold its entire membership on strike, and, through the stoppage of all production in the unionized fields of an essential commodity, to accomplish the placing in jeopardy of the welfare and health of a great unorganized majority of the people by a small, highly organized minority.

A bitter struggle has been waged for years by the United Mine Workers to extend their domination over the non-union fields, and by the non-union operators to keep free from the yoke of national unionism. Much can be said on both sides, and has been.

When asked by the United States Coal Commission, in effect, what ails the bituminous coal industry, the operators' reply stressed:

First. "The effect on production and on the price of coal to the consumer of the monopolistic and absentee control of mine labor in the United States."

Second. "The opposition of organized labor to the introduction of labor-saving machinery."

Third. "The non-observance by organized labor of contracts made in its behalf."

And the reply of the mine workers was equally emphatic under the headline — "Complete unionization will solve the coal problem," that "the ultimate solution for the strike problem in the coal mining industry lies in the complete unionization of the entire industry." In the same reply the mine workers boast that "without fear of contradiction, we say that the American Coal Miner is the best striker in the world," proving it by saying that "453 000 men struck for six weeks in 1919 until a Federal Court decision forced them back to work," and that "they proved it again in 1922" when more than 600 000 went on strike and remained so for more than five months.

Between these two views of the union issue lies the main immediate problem of the coal industry and of the country's coal supply.

I do not contend that all of the blame is on one side and the virtue on the other, or that there are not other and serious problems in connection with coal; but most of the troubles which have been thought of by the numerous critics — certainly the

chief ones — either tie in closely with the nationalized union difficulty, or are matters of technical practice which lend themselves to gradual evolutionary betterment if production can be given stabilization by freedom from widespread strikes and their attending ills.

The coal industry is at present badly out of balance in this important respect: — the operators, who are the employers and managers of the business, are carefully and effectually restrained by the Sherman and Clayton Anti-Trust laws from concerted action or close coöperation with other operators in the conduct of their affairs. Perhaps all this is best for the country, though some of the minor inefficiencies of the industry, such as some unnecessary plant development, certain uneconomical selling practices, etc., can be traced to these restrictions. On the other hand, the mine workers, wherever they have joined or been forced to join the union, are controlled absolutely by a small number of their own labor leaders.

Assuming for argument the correctness of labor unionism and so-called collective bargaining it is obvious that there cannot long survive a successful collective bargaining, or "negotiation," between, on the one side, some several thousand operators (coming from many different parts of the country and representing many divergent conditions and interests, utterly unorganized and unled because of legal restrictions) and, on the other side, a small highly organized group of officers of one union, frequently entirely dominated by one strong personality, with power at will to shut down every mine of every operator on the opposition side.

Since this union has reached its present strength, the so-called "negotiations" of wage scales have been farcical, and the last two national strikes have resulted because of this condition. You have all read in the papers of the futile meetings and the final stepping in of Federal authorities — usually the President of the United States himself — to force a resumption of mining on some purely arbitrary continuation of the status quo.

The industry is now at work under an extension of an old wage scale, at the request of the United States Coal Commission, until March 31, 1924, — virtually an armistice during the coal

investigation. As matters now stand, there is no assurance against another national strike in April of next year — no prospect of stabilizing the industry until a way can be found to adjust wages and working conditions, when changed general conditions make adjustments necessary, in a way fair alike to the employed, the employers and the great coal consuming public.

These are some of the reasons why I place so much importance on this labor situation.

In the operators' opinion, the existence of substantial non-union fields was a national life-saver in 1919 and 1922, and has been and is the only potent check on unbridled demands by the Mine Workers Union.

In the Mine Workers' opinion, complete unionization would give their union power to solve all of the coal problems, which they are confident it would quickly do.

Everybody, including the mine workers, agrees that the coal industry is unstable and needs stabilizing. Almost any study of the instability comes down to the matter of intermittent and insufficient running time for the mines and irregular and unequal work time for the miners. This leads us to the items of over-capacity; over-manning; too high costs because of irregular operation and the existence of many high cost inefficient mines; bad car supply and transportation; irregularity of prices — too high at times and insufficiently high at others; and countless other troubles. But, either as cause or effect, all of these things come back to the door of the national strike. But for the expectancy and almost certainty of a tie-up of whole coal fields about every so often, most of the speculation would be taken from the coal business; mines unfit to compete under normal conditions would not be opened, as they now are whenever a strike or threatened strike puts an unnatural bulge into the price of coal; the railroads would not be called upon to haul two months' coal in one, or to spread their service to twice as many mines as are needed for normal, year-around operations. With stability of opportunity to operate, seasonal variations in demand for coal could be greatly smoothed out by spring and summer price or freight-rate inducements, perfectly possible storage could be encouraged and no doubt accomplished. With

steadier work time the mine worker would make a more satisfactory annual earning than under present conditions, without having to demand a daily wage disproportionately higher than in other industries, which has attracted to the mines more men than can be regularly employed. Steadier operation could not only give to the mine worker greatly improved living circumstances, but would greatly reduce the costs of mining and of transportation, permit safer and much less wasteful mining, conserving a vital resource and making the coal supply dependably regular and available at reasonable cost.

The operators' view is that individual initiative, — properly regulated and restrained where and as necessary in the public welfare, as in the case of the anti-trust and mine safety laws, for example, — is much better than a cumbersome and political government operation; that the natural play of supply and demand will effectively stabilize, if not interfered with constantly by strangling general strikes and resulting artificial stimulations of prices and speculation.

The mine workers' prescription for taking care of the over-manning and over-development is evidenced by their demands at the last attempt to negotiate a wage scale, (which resulted in the 1919 strike), and which demands were reiterated by their Indianapolis Convention in 1922. These demands, based on a continuation of the current wage-scale rates, included a six-hour day, five-day week, with time and half time for overtime and double time for Sundays and holidays.

Obviously it would be an economic tragedy to increase thus greatly the cost of coal in order to keep a surplus of miners in the business, unless the whole country is ready for the thirty-hour week in industry generally, and all that this would mean in readjustment of our national life.

On the other hand, some critics advocate trying to legislate out of business all surplus of mine capacity over that quantity estimated to be just able to meet the country's annual needs when operating steadily. What would happen if this were done without positive safeguard against a paralyzing suspension like that of last summer? With no non-union coal and no reserve capacity, how long a strike would it take to bring the country to its knees?

Another example of the quite different views of employer and employee, is that in recent attempts at conference the operators have repeatedly urged that the union incorporate, or in other way make itself a responsible party for contractual relationship, commensurate with the responsibility before the law of the coal companies with which it seeks to deal; and the operators, often endorsed to this extent by Government officials at the time seeking to effect a settlement, have persistently advocated non-partisan arbitration of questions on which the negotiating parties were unable to agree. Both of these points have been as repeatedly rejected by the mine workers.

I do not think that a majority of, or the major, operators are so much opposed to unionism as they are to the unwieldy and autocratic unionism into which the mine workers have developed. If it has been found wise to restrain monopolistic power in public necessities on the operating or business side, as has been done, why should an absolute monopoly in an essential like mine labor be permitted to remain outside the law. I think it would be the unanimous opinion of every employer who has come in contact with the United Mine Workers of America that an extension of that organization's power over the present non-union coal fields, with a continuance of their present unrestricted powers to strike in unison, would be a national calamity.

Much could be said about the possibilities of continued and marked progress in the substitution of mechanical for human energy in coal mining. This field holds great promise, but will probably continue to meet opposition from men who think that progress in this direction is inimical to their personal interest.

Also, many pages could be written about the possibilities of better utilization of coal; the partial coking or retorting of coal at the mines, or in cities or industrial centres, to save the commodity values by extraction and at the same time make a smokeless fuel not only more economical for heating but tremendously more clean and healthy; saving fuel by such means as firing powdered coal, — or using high pressure, superheated steam, — holds much interest from a technical viewpoint and promise from an economic one. Large extension of the Central Power Station (super-power stations, you might say) with a

transporting by pipe or wire of much of the power that now requires bulky railroad service, is in your minds, I am sure.

I pass these interesting factors of the future coal and power problem because of lack of time, putting the immediate labor control item foremost because I think it is the all important immediate problem to be understood.

I have a belief that this country has an ample coal reserve to meet its needs for many generations to come; that as the demand increases and the easily won coal diminishes, a gradual evolution of methods, both in mining and distribution, and of use, will tend to replace the former more wasteful practices. But I think it is imperative for the country to solve the present unhappy, unbalanced and almost impossible situation existing in the coal labor relationship. As I have said, I don't mean to imply that the mine workers are all wrong or that the operators are all right. It is a great public question which can only be solved by enlightened public thought and opinion.

To quote again from the article of Dr. George Otis Smith — which has added significance because he is a member of the present Coal Commission — “The ‘general welfare clause’ must undoubtedly play an increasing part in national affairs, as a constitutional basis for action to protect the majority against any minority that arrogantly exhibits its indifference to the common good. The aggressive minority may derive its power from its monopoly of a valued resource or its monopoly of skilled labor,— but the eventual reaction of the public will be the same, whether the monopolistic minority wears the label of trust, or of union.”

I hope and believe this is true. The public has already reacted and acted on the trust form of monopoly; it must in time react against and act on the union form of monopoly.

I am sorry to have taken your time with so little reference to the technical and engineering features of my subject, but coal is one of the chief foundations for power and the immediate coal problem seems more social and political than technical or scientific.

If public opinion, informed and stimulated by the present national coal investigation, finds a way to prevent the oft repeated widespread breakdowns of coal production, it will put all other coal problems a long way towards solution.

FUEL OIL.

BY GEORGE S. DAVISON.*

(Presented before The Affiliated Technical Societies of Boston, March 28, 1923.)

THE subject of Fuel Oil cannot be properly covered without a reference to the barrel of crude petroleum from which it is derived, and as a particular barrel of crude oil may differ very materially from other barrels of the same commodity, it would appear that we should cover somewhat generally the petroleum business rather than confine ourselves to the subject of this paper.

Because we prefer to cover the subject quite generally, we do not consider ourselves obliged to discuss the origin of crude petroleum, nor the many places it has been found throughout the world. We shall confine ourselves to such points in relation thereto as affects the United States, and as of this date, except that the growth of the petroleum industry should be referred to as an illustration of its importance in the economic structure of our country.

Petroleum was first obtained by the process of drilling in 1859, on Oil Creek in Northwestern Pennsylvania. In that year 2 000 barrels were produced in that way. Subsequently, successful drilling was extended in a southerly direction to and beyond the south line of Pennsylvania and well into the interior of West Virginia. This area, with the producing area of Kentucky, is known as the Appalachian Field. The extension of the Appalachian Field had reached Pittsburgh, a distance of 80 miles in an air line from the first well, in twenty-five years. By that time oil had been discovered in quite a number of pools in Ohio and Indiana, and perhaps in Illinois. More recently California has produced oil. Since 1900 Texas, Oklahoma, Louisiana, and Kansas have been very active in the producing of oil. Oil in paying quantities is being produced at this time in about

* President, Gulf Refining Company, Pittsburgh, Pa.

twenty of the States. As affecting the supply at the disposal of the United States, the production in Mexico, at least that which is imported into the United States, should be added to what is produced in our own country.

At the end of each twenty-year period since the first year of production, there has been produced in the United States:

Twenty Year Period Ending	Amount Barrels
1880.....	26 286 123
1900.....	63 620 529
1920.....	442 929 000

There are several oil companies in the country, each of which at present is producing at a greater rate than did the whole country in 1880. In 1922 there was produced in the United States 551 197 000 bbls. of which 29 204 000 bbls. was from the Appalachian Field.

Within the first ten years of the refining of crude oil in the United States, the light products now known as the naphtha group were considered a nuisance and danger to the business. The valuable portion of the crude oil was what was called in those days Carbon Oil, which is the kerosene of today. It sold by the gallon retail at about twenty-five cents a gallon. The purchasing power of the dollar being much greater in those days than now, the product had a greater value than the gasoline of today. Lubricating oils were of secondary but of growing importance then.

What a great change has been wrought in the oil industry since those days can be appreciated from the following words that have just been written by a man having a full knowledge of the situation:

"Oil is without doubt one of civilization's most important natural resources. And yet we are just beginning to learn how dependent we are upon it. The wheels of machinery cannot turn, ships cannot move across the seas, our age would come to a complete standstill, without oil. But the world is only now coming to realize the significance of two vital facts, first, that man can no more manufacture oil than he can manufacture a grain of wheat; and, second, that nature's supplies of oil are not inexhaustible."

Among the nations of the world the United States has always stood prominently first with respect to crude oil production. Our country, according to official records produced 64.7 per cent. of the world's supply in 1922; Mexico following with 21.8 per cent. Expressed in barrels, the production of the United States, as previously stated, being 551 197 000 bbls., with the imports from Mexico added, of 123 694 000 bbls. and after allowing for exports, there was available for the United States the gross amount of 665 314 000 bbls. Of the total production throughout the world of 815 540 000 bbls., 749 542 000 bbls., or 88 per cent. was produced upon the Western Hemisphere.

The production of oil is attended with great waste, which naturally adds to the cost of its products. Such being the case, the natural inquiry is, "Why is not such waste stopped?" It is a case of "easier said than done." For some time after the first drilling bit breaks into an oil pool, its area and thickness are not known, and in fact at any time the exact capabilities of a pool can not be determined. Following the usual custom the first drill was started on one of the edges of the lease upon which the well was located upon the theory that if oil is found, part of the oil recovered will come from beneath the adjoining property. If it is drilled as a wild-cat well, the amount of land which the operating lessee is willing to take over in advance of definite knowledge as to the results, is limited, first by the chance he is willing to take, and second, by the amount of money that he can command to back up his nerve. His first venture, provided he has a reputation of being a successful operator, puts all the land for miles around his well under suspicion of being valuable oil territory. The race that follows to get territory in the neighborhood of the prospect becomes a "free for all." Before drilling is begun by others, the land owners must be paid substantial bonuses for leases and until oil is actually produced, there are rentals to be paid. Should oil be subsequently produced a proportion of the oil, or in lieu therefor, its market value, is paid the owner or lessor.

The leases made will contain clauses that are intended to protect the lessors against operations upon adjoining leases, whether these operations are conducted by his own lessee or

others. As the proven well is on the edge of a lease, the lessee across the line from it is taking a lively interest in the well. He may be willing to risk his own money on the confidence displayed by the first driller, and follow his leader very closely, or he may await the outcome of the well. In any event he and many others are making ready to drill. If the first venture is "a well"—an expression in oil country language that means that it will produce—drilling operations in all directions are started, and if it be a big well, the owner of it at once starts tools at every location along the edge of his lease. This action is based upon the same idea as governed him in making his first location—he hopes to drain the adjoining leases and thus add to what is directly under his own lease. However, he has not been so rapid in extending his operations but what offset wells will be started against every one he seeks to drill. Assuming that within the pool the thickness and porosity of the sand, and the rock pressure is the same, the advance guard in the drilling campaign gets the better of their competitors.

There are certain decisions of the courts that control in the matter of producing oil. The ownership of the oil extracted is determined only when brought to the surface, and then it belongs to the party who produced it. A lessee of an oil property must protect his lessor by keeping pace with the drilling operations outside of and along the lines. If a lessee owns adjoining leases he must not wilfully discriminate as between his lessors in his producing operations.

And so it is quite easy to understand why there is such feverish haste to bring the oil to the surface when once its hiding place has been discovered. A new field of considerable area while its production is flush, adds quickly and in large amounts to the available stocks. The drilling of one well nowadays may cost \$75 000 and a producer of limited capital must convert his oil into money as quickly as possible, so that his drilling campaign can proceed with the utmost dispatch. His oil may be worth \$2.50 per barrel as he produces it. If he cannot sell it immediately, he must either shut in his wells or build tankage to hold it. Steel tankage and equipment that goes with it will cost him 50c. to 60c. a barrel. A very ordinary production from

his wells might be 5 000 bbls. per day. While such production is forthcoming, and if he decides to go into the tankage business, he must spend at the rate of \$2 500 per day so that his production may not be retarded. Little of this expenditure is recoverable and the conservative view to take is that it is expense. But he may be fortunate in that the pipe line companies will rush to his assistance by extending their lines to his property, relieve him of his oil and settle with him twice a month for what they purchase. His oil is like the miner's gold, it is the same as money so long as it can be reached by the pipe lines. In the meanwhile the pipe line companies have been keeping themselves informed as to every detail of the drilling operation in the field. Hoping that the field may eventually produce, their engineers rush surveys for the lines that are thought to be needed. Plans are made and material checked off and held in readiness. Little consideration is given to the question of whether the business that will be done in the aggregate in that field, will pay expenses and amortize the cost of the line. That is the risk of the business. It often happens that such extensions result in great losses to the pipe line companies, but just as often they may produce paying results. The aim of these companies is to keep their main lines that lead to the refineries running at full capacity for every minute of time, and the refineries must run substantially that daily amount of crude that will permit them to turn over to the sales departments just what can be disposed of at factory, farm and garage. If the crude oil has a gasoline content of even a small percentage, every second of time is important before distillation and also after gasoline has been produced from it, and every precaution is taken to prevent waste through evaporation. Exposure to the air, the passage through pumps, the storing in tanks, means a loss of a valuable product. It may be a long period after production before the products of a barrel of crude are disposed of to the ultimate consumer. There are millions of barrels of crude oil that have been lying in storage tanks in Oklahoma for as long as fifteen years. All the gasoline that might have been distilled out of it at a temperature of 100 degrees Fahrenheit has long since disappeared, and for each year the taxing authorities have collected an ad valorem tax upon the tanks and contents.

On December 31, 1922, there was at hand at all points in the United States 143 days' supply, in amount 264 578 000 barrels, with a consumption in December, 1922, at the rate of about 675 000 000 bbls. per year.

This is probably as large a margin of stocks as has existed in the petroleum industry for many years. These facts illustrate the narrow margin of the supply of raw materials upon which the business operates, and from which may be deduced the main reason for the severe fluctuations in the prices of crude oil at times. The sales of lubricating oils and fuel oils follow the general trend of business. Kerosene follows the seasons while the sales of gasoline are largely affected by the weather. The law of supply and demand in the industry has a very short perspective.

At the refineries in the United States on December 31, 1922, there were stocks of finished petroleum products of practically 626 000 000 barrels, and a relatively large quantity on its way to the consuming public. The value of the containers to hold all the crude and finished oils indicated is probably \$1 000 000 000. This appalling sum should alone indicate that there is a practical limit beyond which storage of petroleum products cannot be provided. Another practical question, that of the great loss of stored oils through evaporation, tends to limit storage.

The oil business is either a feast or a famine. The irregularity of the supply of crude adds to its cost in many ways. Plans partially carried out frequently must be abandoned. Sudden demands for oil-field goods send prices sky high. Competition for leases affords the land owner an opportunity to milk the business, thus increasing costs. Investments in pipe lines and tankage must meet the conditions of maximum and not average production. The storage of gasoline content crude means a great economic loss. If the crude oil might be drawn from its subterranean pools no faster than it would be needed, immense economies over present methods could be effected. The question naturally arises, "How can it be done?" It cannot be done under the present system of private initiative and ownership; it might perhaps be done under some socialistic order of things, such as government control that would direct every step

of the industry. But this would carry with it other and greater difficulties, such, for instance, as probable lack of initiative in a highly specialized and rapidly changing business.

But to return to some of the easier questions about the oil business. As already related, there was during 1922 made available a total of 665 314 000 bbls. of crude oil, in addition to the stocks of January 1, of that year. During the same period, 460 394 000 tons of bituminous and anthracite coal emerged from the bowels of the earth, an amount smaller by 46 000 000 tons than in 1921. The calorific value per pound of these two products being assumed to be 18 000 and 12 000 b.t.u.'s respectively, it would appear that the total theoretical heat efficiency of the coal would be but 1.75 times that of the oil.

The crude petroleum as it was produced in the field, or delivered as imports, was probably worth an average of \$2.00 per bbl.; the coal perhaps an average of \$5.00 per ton at the mine. Using these values, the relative cost of these two commodities as they leave nature's door is about as follows: coal .21 of a cent per 10 000 b.t.u.'s and crude petroleum .33 of a cent.

The two last statements are made only to illustrate the relative values of these two commodities from the fuel standpoint. They have no practical value.

The character of crude petroleum not only differs very materially between pools, but may differ within a pool, and in fact between adjoining wells. There are many situations where pools are superimposed upon each other. The oils in superimposed pools may differ greatly. Crude petroleums differ as to their bases — paraffine or asphalt; or a mixture of both. They may differ as to whether they are high or low in lubricating value, or perhaps better stated, lubricating content. They may possess or be void of gasoline or kerosene content. The statement that an oil may lack this or that form of product means that such content forms, under existing conditions, too small a value to make its extraction profitable. For instance, some crudes may only be valuable as fuel and yet they may contain a sufficient trace of gasoline to make them dangerous for use under boilers.

Gasoline content crude may differ all the way from 18° Baumé (0.9459 specific gravity) to 44° Baumé (0.8045 specific

gravity), the higher Baumé gravities indicating higher percentages of gasoline, or kerosene, than the lower ones. It should be noted that tests for quantity and quality determine content, while the expressed gravity of an oil means but little.

Crude oil in the field should, and to some extent does, bear a close relation to the marketable value of its combined products, but naturally transportation charges on the crude to the refinery also have some bearing upon the field price. Pipe-line transportation is cheaper than rail service. At the present day too great a proportion of refining capacity is located in and adjacent to the western oil fields. Assuming that they can be served with crude oil by pipe lines from the field, the most desirable locations for refineries are as close to their markets as possible, and if local markets permit, refineries should be preferably upon deep water where service can be had by ocean-going steamers.

Considering the oil situation with respect to all that part of the United States east of the Rocky Mountains, but 12 per cent. of the gasoline content crude is produced east of the Mississippi River. In 1922 the refineries east of the Mississippi and north of Louisiana handled but 45 per cent. of the crude run, while 65 per cent. of the population of the whole area resided in the states, and adjoining ones, where these eastern refineries were located; or, putting it the other way, in the western oil fields where 88 per cent. of gasoline content oil is produced, 35 per cent. of the population reside, and 55 per cent. of the crude oil is refined. Five large refineries on the Gulf Coast assisted in evening up conditions between refinery output and population, but it can be appreciated that large quantities of petroleum products, or the equivalent in crude, had to move east from the Mid-Continent district to adjust the western supply to the eastern demand. Generally speaking, there being an excess of manufactured products in the West, that is the place where the lowest, or basic, prices exist. As one travels eastward or southwestwardly from this basing territory, rail freights determine the upward trend of prices. A great deal is said by persons who speak without knowledge of the facts, about discrimination among districts in the sale of gasoline being practiced. The price that a consumer may pay to concerns other than refiners is not to be

taken as an indication of the market. The tank-wagon price of the refining companies, which is practically the wholesale rate to dealers, is the correct gage. If one will take the trouble to chart the tank-wagon prices eastward from the Mid-Continent field as of any time, he will discover that rail freights on gasoline from the points of excess supply will explain the difference in the tank-wagon prices. Here and there, covering a temporary period, the tank-wagon price may be below what would seem to be the proper one, but it will in every such case appear that a price war is on. When the stress of such a conflict is over the price returns to its relatively natural position.

Aside from the economic waste in the production of the crude which has been pointed out, there exists fully as serious waste, which could and should be eliminated. It arises through the ordinary refining operations conducted at or near the oil fields. The refining capacity in the Mid-Continent field today is fully 50 per cent. in excess of its actual output, while eastern and southern refineries on deep water are fully occupied. Of the western refineries, a large majority are of a cheap and temporary character and run to produce gasoline, with fuel oil a by-product.

The demand for the latter product is much below the supply. Eastern refiners by advanced methods strive to increase the percentage of the valuable products, which means a reduced proportion of fuel oil. Their crude supply is delivered by ship and pipe line.

Reference is here made to another misunderstanding of the public about the oil business, — a misunderstanding promoted by politicians who can hardly be as ignorant as their statements with reference to oil pipe lines would indicate. It is represented that such lines are constructed by the large companies that are engaged in the oil business, and that while taking advantage of the right of condemnation for their rights of way, refuse to transport the oil of their weak competitors. The transporting of oil by pipe line was carried on for some time before the right of eminent domain was conferred upon such enterprises. The law-making representatives of the public conferred such rights, not primarily to suit the companies, but in the interest of the public. The conferring of such a right naturally made the pools of oil

more accessible to the public. Long after the right of eminent domain to pipe-line companies had become popular, Congress (as recently as June 29, 1906) amended the Interstate Commerce Act and declared oil pipe-line companies common carriers. That was a step easy to take, but the passage of the law has had no material effect upon the movement of oil through pipe lines as revenue producing shipments. And there are practical reasons why this is so. In the first place, no oil pipe line was ever constructed for the purpose of carrying oil for any other interest than that of the owner; or if there be exceptional cases, such lines were built upon some guarantee intended to provide not only operating expenses, but earnings sufficient to amortize the investment, or upon some financial plan of equal security to the owner of the line. Such lines are projected and built to carry from producing fields crude oil equal in amount to the capacity of the refinery or the refineries which it serves. In effect, therefore, it bears the same relation to the refinery that any delivery service from the refinery set up by the owner does. So far as the practical effect upon the refinery is concerned, Congress might just as well decide that the ships or trucks engaged in delivering goods from the refinery may be used by a competitor, when the latter is unwilling or unable to supply his own facilities, but who, in lieu thereof, is willing to pay just compensation for the use of the facilities that he may take. However, while paying just compensation for the use of an accessory to the refinery plant, he is throwing idle the refinery in the ratio of the capacity taken. In a certain case that may be mentioned, a corporation engaged in every step of the oil business has exactly twice the investment in refineries and ships that it has in its pipe-line system which is wholly and fully engaged in serving the refineries. It is compelled by law to publish tariff rates for the service it may perform in piping oil for others. These rates should be based upon operating costs, plus a reasonable return upon the investment in the pipe-line system. Great injustice would be done should a competitor of such a corporation compel the former to shut down its refinery and scrap its ships to the extent that its pipe-line capacity was taken from it by others. True, additional capacity could be added by the owner of the pipe line. It would

be equitable, in such a case, that the competitor should protect the added investment and expense of the owner of the pipe line involved by serving the competitor. The Interstate Commerce Act, as amended to cover oil pipe lines, affords no such protection to oil pipe-line owners.

As a matter of fact, it seldom if ever happens that a demand for pipe-line service is made. Pipe-line companies are not only transporters of crude oil, but they are purchasers of that commodity. In Oklahoma the statutes give a pipe-line company the option to be a common purchaser or a common carrier. Being a common purchaser is less likely to result in embarrassing situations, except in times of over-production, in which case the intention to be a common purchaser must be lived up to by the method of prorating purchases. The independent producer greatly prefers to sell his oil as he produces it. In times of over-production he may have to tank it, but if he sells as he produces he gets his cash every two weeks, and his worry is reduced to the single operation of getting production.

Let us now turn to the question of the use of oil for fuel. The immense amount of potential energy in a year's supply of crude oil in the United States has already been illustrated. But oil for lubrication is more necessary than for power, so that the necessities in this direction must be deducted from the whole in determining the net that may be used for power purposes.

To what use the balance of the crude oil may be put depends upon many circumstances and conditions with relation to problems of trade, commerce and living. Gasoline, the more volatile portion of crude oil, has become the principal source of power for moving vehicles and small power boats. Kerosene, the next product in point of specific gravity, has always been in demand for lighting purposes, and more recently for house heating purposes, and still more recently to replace gasoline for power for farm tractors and like purposes. Gas and fuel oils are the heavy ends of the crude, that are left over after all other product of higher merchantable value have been extracted. Among those not already mentioned are wax, medicinal oils, paint products, road oil, asphalt and coke.

From the 555 000 000 bbls. of crude that was run through the refining stills in the United States in 1922, the results were:

Gasoline.....	6 202 234 613	gals. or 26.6 per cent. of the crude.		
Kerosene.....	2 306 326 489	"	9.9	" "
Lubricating Oils..	987 752 469	"	4.2	" "
Gas and Fuel Oil.	10 706 226 570	"	45.9	" "

The above amount of gas and fuel oil may be expressed as 254 910 000 bbls.

In addition to this there were 64 215 000 bbls. of fuel oil imported from Mexico. There were also about 3 650 000 bbls. of domestic crude used as fuel. These amounts total 322 765 000 bbls. of fuel oil available in the United States for 1922.

The average costs to Boston consumers during the year 1922 for the main petroleum products were about as follows:

Gasoline per gallon.....	\$.25
Kerosene per gallon.....	.14
Lubricating Oil per gallon....	.35
Fuel Oil per barrel	1.50 for Heavy Mexican
Residuum Fuel Oil per barrel	2.10

The average selling price of all products in an average barrel of crude oil was about \$3.75 per bbl. or 9c. per gal. Based upon the fairly accurate rule that one ton of high-grade bituminous coal is equal to $4\frac{1}{2}$ bbls. of fuel oil in heat efficiency, it will be seen that fuel oil at \$1.50 per bbl., unless it has other advantages over coal as a fuel, is not as cheap as is coal at \$6.75 per ton. It can also be understood that assuming any scale of prices for the products of a barrel of crude oil, the selling prices of the two valuable products, to wit, gasoline and lubricating oil, must be high enough to maintain the prices of fuel oil low enough to meet the competitive price of coal.

For the purpose of securing energy from fuel oil, the latter may be used in internal combustion engines or under boilers for furnishing steam. The Gulf Companies were the pioneers in the adoption in a large way of the internal combustion engines, with crude or fuel oil as fuel. This organization has two hundred of such engines in use, with a total horse power in excess of 15 000. One of these is of the Diesel type of 150 h.p. All of

the others are of the Hornsby-Akroid type. The compression in the Diesel engine is thirty times; in the Hornsby-Akroid from twenty times and downward. These engines are used principally in pumping oil through pipe lines. The station duty of the latter engines shows an average consumption of $\frac{6}{10}$ lb. of fuel per brake horse power hour. Straight crude right out of the pipe line is used. This oil generally is about 40° Baumé. Theoretically it has about 19 850 b.t.u.'s but in practice it will average about 18 400 b.t.u.'s. This is an efficiency of 23.4 per cent. In this consumption is included the operation of all auxiliaries, including water supply and lighting. The engines operating the power pumps, which are directly connected to them, will show an efficiency of about 28 per cent. and a consumption of .5 lb. per h.p. hour.

In the matter of using fuel oil under boilers, units of 200 h.p. or over, with well-designed furnaces, will operate at about 76 per cent. efficiency. With this information, and using a price of \$1.50 or \$2.10 per barrel (the price indicated for Boston last year) a comparison could be made with coal at a given price used under boilers of known efficiency. In the use of oil as against coal, there are certain credits that can be applied, the amounts being determined only from actual practice. They may be mentioned as saving in labor in handling coal and ashes, and an allowance for cost of operation and interest on labor-saving devices, 25 per cent. less storage space, the location of storage space can be a matter of choice, the intensity of the fire more easily regulated, and much less disintegration in fuel.

While we have said that the Gulf Companies have a large horse power engaged in handling the oil through pipe lines, they have one large steam-operated station at Sour Lake, Texas. There are five 200 h.p. boilers, equipped to give a fairly high efficiency with respect to the boiler pressure carried.

This plant has averaged $14\frac{3}{4}$ lb. of water from a feed water temperature of 208° to 150 lb. gage. The oil burners and boiler-room auxiliaries require 5.5 per cent. of total steam generated, so that the net evaporation is 13.99 lbs., which means a boiler efficiency of 76 per cent. This boiler plant operates six Corliss engines each developing about 180 brake horse power. It

delivers 9.5 per cent. of the total heat in the oil to the pump ends. A steam plant in one of the Texas oil fields, producing electric power for varied uses, with an equipment of three 500 Westinghouse turbines, two being operated continuously, shows an efficiency of 9.4 per cent. at the switchboard. A public utility plant nearby, with oil for fuel under the boilers and using two 1 500 k.w. turbines, secures an efficiency at the switchboard of 9.6 per cent. Here are three plants operating on oil that might be said to average 9.5 per cent. efficiency. I assume that at all three plants the boiler pressure is 150 lbs., which relatively low pressure must be borne in mind in comparing these results with other plants.

This performance can be compared with the data already given, of $23\frac{3}{4}$ per cent. efficiency upon an oil-engine power pump plant.

In concluding this paper attention should be called to several recent developments that may affect the availability of fuel oil for industrial purposes. There have been two general grades of oil produced in Mexico. One is classed as light gravity, being 18° to 22° Baumé. From this oil can be obtained from ten to twelve per cent. of gasoline. Being treated for these products 85 per cent. of 16 gravity fuel oil results. For the past two years this supply and operation has meant fully 80 000 000 bbls., or about one-third of the available supply of fuel oil in the United States. The fields producing this character of oil have shown a very heavy decline within the past twelve months. The heavy Mexican crude, which is about 12° Baumé, is not refined but is used direct for fuel. About 35 000 000 bbls. of this oil per annum have been brought into this country. This product also shows a decline. Thus the general supply of fuel oil in the United States has suffered great curtailment.

Until a few years ago the gasoline was extracted from crude oil by the method of heating in stills. Gradually cracking processes for the purpose of increasing the percentage of yield have been installed. These cracking processes, in increasing the yield of gasoline, curtail the supply of fuel oil. Some plants which formerly showed a gasoline yield of 25 per cent. have increased that to 50 per cent. The end is not yet, as to such in-

creases, and the plants that now crack inefficiently, or not at all, must fall in line with the plants that are doing the best work along these lines. Therefore unless additional fields for the production of gasoline content oil can keep up with the increasing demands for gasoline, the supply of fuel oil will be still further reduced.

So far with respect to the general supply of fuel oil for the United States. It was about 1912, as we remember, that the United States Navy followed in the wake of the British Admiralty in using oil for fuel upon its fighting ships. Now, no unit of the Navy is designed to use coal. The great ocean liners were being equipped for oil at the beginning of the World War. Some of the more important ships of the character formerly equipped to burn coal are being converted, and all new ships are being so equipped. As an example of this change in fuel for merchant ships, it may be stated that in 1922, American dealers delivered to this class of ships 51 996 000 bbls. of bunker oil against 43 053 000 bbls. in 1921. The use of oil for fuel is now a necessity, and it will be used at sea whether or not there remains any supply for uses ashore. This situation means a less supply for industrial plants unless new fields can be found.

As to the question of power for the future, while to some extent it will be reflected in that inexorable rule of supply and demand, yet it must bear quite an intimate relation to the price of coal or any other fuel. It is a by-product and must be disposed of at every refinery so that the plant can operate. It cannot be stored in relatively large quantities. Gasoline, and to some extent lubricating oil, bear the great burden of cost, and they must continue to do so. The combined income from the various products of an average barrel of crude must be maintained at an amount sufficient to bring the crude from the earth, refine it, market it, and yield a reasonable income. High amortizing rates must be applied, because of the unusually great hazard of the business. Notwithstanding what has just been said, you need not anticipate \$1.00 a gallon gasoline. That expression was coined recently for no honest intention. It is to be hoped that the voter who owns a gasoline car will not be duped by such political twaddle.

In conclusion let us say that no other of the important industries of this world can show so wonderful a romance of courage and initiative as the oil business. Its only fault is its inefficiency, which is due to the necessity of a most rapid development to meet the great economic changes of the past dozen years. But such inefficiency is being rapidly remedied through the application of brains and capital. At present it is but a cloud with a silver lining, in fact, a reserve, which as it is drawn upon will do much to stabilize the prices of petroleum products.

WATER POWER.

BY CHARLES W. KELLOGG.*

(Presented before The Affiliated Technical Societies of Boston, March 28, 1923.)

My subject is too broad for an extended treatment of it in the brief time at your disposal. Therefore, I shall limit myself to an attempt to touch what seem to me fundamentals in the relation of water power to coal and in the economics of water power in general.

It is fitting that water power should be discussed in conjunction with coal and oil, because water power as an economic factor is bound up with the fuel situation and except as an economic factor water power has little practical meaning. In a word the great apparent advantage of water power over power produced from other sources is that the fuel costs nothing.

EFFECT OF PRESENT FUEL PRICES.

The thought has been expressed that the present high cost of coal makes the development of water power now more desirable and also presumably more profitable from the viewpoint of the investor than was the case ten or twenty years ago. I question if this is so as to construction now undertaken. Of course there is no doubt that the higher cost of coal today compared with ten years ago works to the advantage of a water-power property constructed at costs prevailing ten years ago, and the securities of hydro-electric companies so circumstanced are among the choicest investments today, but how about the plant constructed at the present time? I think it will be admitted that the general level of prices at any time depends upon the cost of labor and the prevailing interest rates. This is just as true of coal as of steel or the other component parts of a water-power or steam-power plant, so that, by and large,

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the cost of producing water power, consisting of interest charges on the plant built at present labor (and consequently material) costs, bears substantially the same relation to the cost of coal as it did ten years ago.

The above reasoning assumes that the supply of coal now and for a reasonable period, say at least a generation, in the future will be ample enough so that labor and money costs will in the long run determine coal prices. I say in the long run because I am forced to believe that no aggregation of labor can permanently keep up a wage scale for coal mining, or for any other great division of the nation's industry, which varies much from the fair value of that labor in relation to other commodities. We are assured by those who are advised on the subject that, taking the country as a whole, the bituminous coal resources are almost intact, which for a generation would put the effect of supply on coal price out of the question. Published figures show estimated coal resources for the United States, including Alaska, of 16 billion tons of anthracite and 2 155 billion tons of bituminous, not counting 2 054 billion tons of sub-bituminous and lignite. This would indicate anthracite exhaustion at present consumption rates in about a century and a quarter and a bituminous duration on the same basis of present consumption of 3 600 years. Of course consumption will steadily increase as it has during the last 20 years (40 per cent. in that period in the case of anthracite and over 145 per cent. for bituminous), and the estimates of fuel resources probably are very inaccurate, but they indicate in a general way that the end of the anthracite, while distant, is in plain sight, and that the bituminous coal probably has a long future life.

It will be understood, of course, that the foregoing conclusion has reference only to the relative change, if any, in the economic status of steam and water power in any given section, rather than to the economic value and importance of water power in localities where fuel is scarce and costly. The tremendous present activity of water-power development in France and Italy (where such development is economically sound in spite of the weak financial condition of those countries) and on our own Pacific Coast (where the combination of expensive

fuel and great water powers that can be developed at relatively low cost make such developments inevitable) are typical of what water power can mean in making good a deficiency in fuel supply.

THE CONSERVATION QUESTION.

It seems, therefore, that there is no impelling reason from the price of coal alone for any special activity in water-power development at this time. What shall we say on the broad subject of conservation of our fuel supply by the greater development of water power? This phase of the subject has produced more oratory than perhaps any other. Many who read the Government statistics of the total undeveloped available water power in the country (about 20 000 000 h.p.) and think of all this energy running away idly to the sea and then think of how many million tons of coal this power, if harnessed, would save per year are likely to raise their hands in horror at the sinful wastefulness of our generation. This frame of mind is arrived at because the economics of the situation are not clearly perceived. The situation is similar to that surrounding crop yields per acre in this country. It is frequently noted that the average yields per acre of farm crops are much larger in England, France and Germany than in the United States and the conclusion is reached that we are a wasteful and prodigal people and poor farmers into the bargain. This conclusion regarding crops is as unwarranted as that previously mentioned as to water power and the reasons are basically the same in each case, namely, that there has been no economic reason for doing otherwise than has been done, and in business matters, until there is an economic reason for doing something it simply isn't done because it is to no one's pecuniary advantage to do it. People don't spend vast sums to develop water power for the purpose of conserving coal for our grandchildren, but because they believe they will be able to sell the power produced so as to get an adequate return on their investment and do it in competition with any other source of power; and similarly farmers can't afford, just for the statistical showing of a high yield per acre, to spend money on fertilizer if there is plenty

of land to raise the necessary crops to supply the existing demand without using fertilizer. No one doubts that when our population reaches 200 000 000, if not before, we shall have to use fertilizer in vast quantities and enormously increase our crop yield per acre, with the alternative of starving, but until it is an economic proposition to change farming methods, our farmers won't change.

The same principles have always held true and of course always will. How often we hear the exclamation with regard to the pyramids of Egypt. "What a sinful waste of labor!" It seems so today when the jobs for labor are legion and when the supply of labor is low and the price is high. Doubtless when the pyramids were built, however, labor was relatively plentiful and cheap, and quite likely the pyramids were an economically wise construction development to keep people from fighting among themselves from idleness.

WHAT ELECTRICITY HAS DONE FOR WATER POWER.

If we are agreed that neither the relative price of coal nor the desire for conservation can be a true basis for water-power development, it is interesting to consider the factors that have affected water-power development in the last twenty-five years as compared with production of power by coal.

To begin with, the fundamental reason why water power has been developed to a relatively great extent in the last twenty-five years is electricity — not only as a form into which to change the energy in the water, but particularly in the ability it furnishes to transmit the power relatively great distances from where it is produced. In fact the progress has been so rapid in extending the distance that electric power can physically be transmitted without over, say, 10 per cent. loss of energy, that for most cases the financial aspect of the transmission (its cost in interest charges and maintenance) has become the determining factor rather than the physical aspects of the problem. The result has been that with the highest transmission-line voltages now developed, the line investment for a line of the length to justify such voltage would be economically advisable

only for the transmission of very large amounts of power. The higher the transmission voltages become, the greater the distances that power can be carried with losses commercially allowable, but as the cost per mile gets greater with the voltage, the amount of energy required to make an economic transmission also becomes greater.

In order to make this statement a little more concrete, I have had prepared some approximate line costs for various transmission distances and loads transmitted over 110 and 220 k.v. circuits. In order to apply these costs to actual figures, it is necessary to assume definite quantities for load factor, fixed charges, allowable energy loss from transmission and cost of hydro energy at the generating switchboard. Selecting figures for these quantities, which my experience indicates are fair values, it shows that if 3 mills per k.w.h. is about all the traffic will bear as the burden of transmission costs, 200 mi. is about the limit for economic transmission at 110 k.v., but that with the same assumptions this distance can be stretched to 250 mi. if it is allowable to pay 4 mills per k.w.h. for the transmission.

With similar constants assumed we find that with a 220 k.v. line of 300 mi. in length we do not get down to a transmission cost of 3 mills per k.w.h. until a load of nearly 200 000 k.w. is reached, and even for a quarter of a million kilowatts the transmission cost is $2\frac{1}{2}$ mills per k.w.h.—a burden of no small size; the transmission costs for 50 000 k.w. over a 300-mi., 220-k.v. line figure over $7\frac{1}{2}$ mills per k.w.h.

Another way of expressing the transmission relation is to say that the transmission cost per kilowatt hour is about the same in sending 25 000 k.w. 100 mi. as in sending 250 000 k.w. 300 mi. In a word, if you are going to carry power a greater distance than 150 mi. transmission economy is impossible without a large amount of energy to transmit.

RELATIVE ECONOMICS OF WATER AND STEAM.

Let us consider now just how the relative economics of power production by water and steam have developed in the generation since 1900. That year was about the date of the first large hydro-electric installation at Niagara Falls and may be taken as the beginning of the great water-power developments of our time. Compared with the 50 000 h.p. developed in that installation, the present developments (with over 2 000 000 h.p. now under various stages of construction in this country) indicate a wonderfully rapid progress since 1900. The total water-wheel capacity of the United States, as ascertained by the United States Geological Survey over a year ago, was about 7 853 000 h.p., so that a total of about 10 000 000 h.p. in water wheels will doubtless have been attained in this country within a year or two.

Yet during that period from 1900 to the present time the economic improvement in power production has been much more striking with steam than with water power. While the size and head range of water turbines has greatly increased, their operating efficiency has grown only from about 76 per cent. to 84 per cent. (maximum efficiency from 85 per cent. to 93 per cent.) a relative gain of 10.5 per cent.; during the same period, the corresponding efficiency of steam prime movers in kilowatt hours per ton of coal has increased about 90 per cent. for the same size of plant. Not only has the thermal efficiency of steam plants grown as stated, but the actual cost of generating units in dollars per kilowatt has decreased 67 per cent. since 1900 in spite of the unit cost of materials having practically doubled during the period. And finally, the area required for 30 000 k.w. in steam-generating capacity has decreased since 1900 about 89.5 per cent., effecting a corresponding reduction in building costs.

The practical effect of these changes is that with the economies, prices for coal and plant investment existing in 1900 and the corresponding figures today, and allowing in each case a transmission cost for water power of 3 mills per k.w.h., a water power plant, to compete on an even basis with a steam plant

in this section, must be built for 35 per cent. less in dollars per kilowatt than twenty years ago. As, however, the price index has increased over 85 per cent. during the period considered, the relative net gain is even greater in favor of steam, for the water power that could be built for x dollars per kilowatt in 1900 would cost about 67 per cent. more dollars today, even after allowing for the improvement in water-wheel efficiency in the interim.

The importance of these great gains in steam-plant efficiency, even in a discussion of water power, arises from the fact that in the most populous parts of the country the amount of available water waiting to be developed is relatively small compared to the power needed. The report of the United States Geological Survey mentioned above, indicates that over 80 per cent. of the undeveloped water power of the country is in the Pacific, Mountain and South Atlantic States, which contain less than 22 per cent. of the population of the country, and about 14 per cent. of its wage earners and industrial activity generally. Furthermore, of the other 20 per cent. of undeveloped water power in all the rest of the country, 78 per cent. has been developed already, so that for the present, at least, high efficiency in steam power production really affects more people in this country than the further development of water power.

HYDRO DEVELOPMENT WORLD WIDE.

The manner in which high-priced coal has stimulated water-power development is clearly shown by statistics from other parts of the world. The following figures are quoted from consular reports as of 1920 for various foreign countries published January 6, 1923 by the *Electrical World*. In that year 23.7 per cent. of the energy for electric light and power manufactured in the United States was produced from water power, the balance largely by steam. In the same year Mexico produced 75 per cent. of its light and power energy from water, Canada 88.2 per cent., Brazil 80 per cent., Peru 85.7 per cent., the Scandinavian countries 89.5 per cent., France 62.5 per cent. Spain 79.2 per cent., Italy 71.4 per cent., and so on. Taken

by continents, the per cent. of total light and power energy from water was greatest in Europe; North America was also exceeded in this respect by both South America and Asia, this result being probably due partly to our vast coal deposits and partly to the short distance from water power to market in Europe.

Looking far into the future, when the coal supplies of the world are nearing exhaustion, it is interesting to consider the water-power map of the future world based on the consular reports above mentioned. These indicate that the total potential water-power of the world is about 439 000 000 h.p., of which 190 000 000, or over 43 per cent. is in Africa. The other continents show: North America 62 million, South America 54 million, Europe 45 million, Asia 75 million and Oceania 13 million. In this connection the future is far from dark for our teeming industrial district east of the Mississippi and north of the Ohio River. This district, while comprising less than 14 per cent. of the country's area, contained at the last census about half the population and nearly three-quarters of the wage earners and manufacturing investment of the United States. The St. Lawrence River and Great Lakes, combined with the great streams flowing into them from Canada, have a potential power of nearly 12 000 000 h.p. which should mean a great deal to our grandchildren and their heirs in this section. For I believe that we are safe in assuming that when the great human need is apparent, the narrow sectional view of water power, which has recently appeared in certain sections will be swept away in the realization that electric power knows no political lines.

THE FINANCIAL ASPECT.

Many a water-power development which works out satisfactorily on paper cannot be carried out, due to financial considerations. These difficulties arise from the time required for constructing a great work which has no earning power during the construction period, and subsequently the even longer time needed to get sufficient business connected to produce the earnings necessary to carry the charges on the investment.

In a great water-power project like some that have been discussed in recent years, which propose to produce over a million horse power with a construction period of five years, the financial difficulties are very great. Not only would interest during construction and operating losses during the development years probably add at least 50 per cent. to the investment otherwise necessary to produce the plant, but the sale of the securities under present day money conditions would be most difficult. High income taxes have driven large amounts of free capital into non-taxable securities (which are industrially unproductive) and the general high cost of living, and of government, have further conspired to make investment funds so scarce that the investor is able to exercise a good deal of discrimination as to what he puts his money into. He can hardly be blamed for preferring securities based on actual performance and existing earnings over several years past, rather than on expectations for the future, necessarily prefaced by a long construction period when a lot of money is being spent and none taken in. Firm power contracts with financially reliable companies covering enough of the output to assure the charges being earned are a minimum condition for financing a large water power, but even this condition would leave such financing far from easy at this time.

In most cases great steam power plants have been built by a going concern with earning power to carry the charges on the new station unit from its existing operations, and with the new business coming in at a rate to load up the new unit fairly quickly. Steam power in raising money for its construction and development has therefore practically always had existing earnings as a basis for credit on which to raise money.

This thought leads to another, namely, that steam power development can be undertaken step by step without sacrificing either economy or convenience in the process, while most water powers require the principal part of their investment to be made initially and before any earnings are available. A notable exception, which, however, proves the rule just stated, is found in the successful water-power developments constantly being made by the great public-utilities companies of this country,

especially on the Pacific Coast. In all these cases the earning power of the existing company forms the basis for financing the water power.

OPERATING CONSIDERATIONS.

There is probably no subject which persons think they know all about, but regarding which it is necessary to be most careful to avoid error, than load factor.

One of the commonest fallacies regarding load factor is the belief that any industry or process that runs continuously night and day has a 100 per cent. load factor. In practice, there is no such thing as a 100 per cent. annual load factor, and yet there are numbers of cases where such a load factor can be shown for a consecutive twenty-four hours. A typical case is a cement plant which frequently has a 100 per cent. load factor for a day but seldom better than 83 per cent. for a month or 73 per cent. for a year.

The effect of these considerations on water power versus steam power is this. The load factor on a steam station has a direct effect on the fuel economy, and fuel is the largest single element in the total cost of producing steam power. Furthermore, with steam generation, the *daily* load factor is the one which has this direct effect. With a water power, however, although the load factor affects directly the largest part of the cost per k.w.h. (in this case the fixed charges) yet it is the annual and not the daily load factor that is controlling. This is because the fixed charges per k.w.h. are the total annual charges divided by all the energy manufactured during the year. This means that for the same general power load the effect of load factor is about $\frac{3}{4}$ as favorable to a water power as to a steam power station. This unfavorable comparison is further emphasized by the fact that the true fixed charge part of the unit cost of power is based on the energy output with respect to the total plant capacity rather than to the peak of the load for the year.

Under certain special conditions, however, the effect of load factor in a combination of a large steam system fed by a

water-power plant may be used to the great mutual advantage of each. If, for example, no considerations of navigation or other water rights interfere and a sufficient reservoir capacity is available to permit of storing all water most of the day, a water power operating thus in conjunction with a steam system can be made effective for three or four times its hydro capacity under normal load factors by being used to swing a peak of large size for three hours daily, instead of carrying a going load factor for twenty-four hours. This not only has the effect of saving investment in both steam and water capacity, but improves the load factor and hence the economy of the steam station. Such a combination may be unusual but is entirely feasible unless navigation requirements prevent. It would obviously be impossible, for example, on the St. Lawrence River.

One of the ever recurring problems of water-power operation is that of excess energy and in general the great difference between the true primary power, as gaged by the lowest flow in, say, twenty-five years and the amount available for, say, 80 per cent. of the time. The difference between these two figures is often very great and has probably caused the operators of water powers as much study as any feature of the business. In practice, excess energy in considerable quantities can be sold permanently only either through the agency of a steam relay to step it up to the primary grade, or by selling to some public-utility company of large capacity, which can adjust its steam operation so as to absorb a large amount of excess energy. In this case, of course, the energy must be sold at a price per k.w.h. lower than the corresponding fuel cost of the utility. In many cases the water-power plant may need capacity in the dry summer when the steam-plant peak is lower than the peak for the year, so that a very desirable offsetting exchange of excess hydro energy and spare steam capacity can be worked out between two such companies or between two plants, water and steam, owned by the same company.

CONCLUSION.

It may have seemed that my attitude toward water power is that of an unfriendly critic. That is not the case. I am convinced, both from experience and judgment, that a good first mortgage bond on a water power, whose economics are sound as to cost and market for its product, is one of the safest securities in the world; the stock of such a company is fit to hand down intact to one's grandchildren. I believe, however, that water power, like many other subjects of national interest, has been made a fetish, and one of the purposes of my paper is to point out that water power in itself, without regard to the existing conditions of fuel, market for power and the cost of the water power project itself, is meaningless. The already extensive development of water power in this country will doubtless continue, but so also will the development of steam stations go on; and we, as engineers, must see that our clients do not go into water-power projects unless and until the economic basis of the development with respect to fuel and markets is carefully explored.

PRECISE LEVELING IN NEW ENGLAND.

UNITED STATES COAST AND GEODETIC SURVEY TO RUN LINE FROM PROVIDENCE, R. I. TO PORTLAND, ME.

ABOUT the first of July, one of the precise leveling parties of the United States Coast and Geodetic Survey, which is now operating in Connecticut, will begin work in Rhode Island. During the past year a line of levels has been run between Rouses Point, N. Y., and Portland, Me., and another is under way between New York and Providence, R. I.

In accordance with present plans, a party will run during this summer a line from Providence, along the New York, New Haven & Hartford Railroad, through Attleboro, Mansfield and Readville to Boston. From Boston the party will work northward along the Boston & Maine Railroad, through Salem, Newburyport and Portsmouth to Portland.

In reply to a letter from the secretary concerning this work Mr. R. L. Faris, Acting Director of the United States Coast and Geodetic Survey, states:

"I am glad indeed that you are interested in the leveling in question, and I hope that our work may prove to be of the greatest benefit to the engineers along the route. With this idea in view, would it not be well to have the city engineer of each of the settlements along the route coöperate with our party to the extent of establishing a number of permanent bench marks in suitable places which can be tied into our line by our party? These bench marks would form a sort of network for each of the cities in question. . . . Any bench marks that are established should be in places easily accessible to the leveling party."

Different data are used in many of the municipalities in Massachusetts. The city of Boston bench marks and those in a large number of cities and towns in the Metropolitan District refer to "Boston City Base," which is about $\frac{64}{100}$ of a foot below mean low water. Surveys made by the railroads and by state

departments have served to tie in the various data to some extent.

If good permanent bench marks are established in the vicinity of the proposed line of levels, the Coast and Geodetic parties will connect with these points and the average constant can easily be determined so that correction to the government datum can be made at any time.

Shore-line subsidence over a period of years has been a subject on which little accurate data is available, although considerable interest has been shown concerning it. Reliable information is dependent upon the establishment of permanent bench marks with sets of levels taken on them at regular intervals. The most satisfactory results can probably be obtained by profiles over a series of bench marks extending at right angles to the coast and for a number of miles inland.

It is expected that several lines of levels can be run in the vicinity of Boston by the United States Coast and Geodetic Survey for the particular purpose of securing information on shore-line subsidence and for establishing a network of bench marks for further studies on this subject.

The Director of the United States Coast and Geodetic Survey desires to make the work of that department of the greatest value to the engineers in this vicinity and is anxious to secure the coöperation of the members of the Boston Society of Civil Engineers.

Details of the leveling between Providence and Portland, which will probably start northward from Providence about July 1, 1923, may be obtained from the office of the Director of United States Coast and Geodetic Survey, Department of Commerce, Washington. The secretary of the Society will be glad to transmit to those in charge of the leveling any suggestions as to methods of carrying on this work which will increase its value to civil engineers in this vicinity.

ACTIVITIES OF THE FEDERATED AMERICAN ENGINEERING SOCIETIES.

MASSACHUSETTS STATE ADMINISTRATIVE COMMITTEE PUSHING IMPORTANT WORK.

WITH the members of Congress busy in their home districts getting ready for the important legislative program that is already beginning to take shape, there is an exceptional opportunity for constituents to make their wishes known. Already sixteen state administrative committees have been organized and plans are in progress to complete these committees so that there will be an organized body of at least five engineers in each state, looking after the local interests of the Federated American Engineering Societies.

It is the function of these committees to be the direct point of contact between the Federation and the activities of engineers and engineering organizations in the states. Through the medium of these committees it is planned to extend the object of the Federation as thoroughly and comprehensively as possible so that it will more truly be a medium through which the engineers may be of the greatest possible service to the community, state and nation and to the profession. This, of course, involves matters of national legislation, since all such legislation affects in some way one or more of the states. It is also the desire of the Federated American Engineering Societies to be as useful as possible in bringing about suitable organizations for the benefit of local engineering groups so that the engineer may have a greater interest in his profession and also be of the greatest possible service to his community.

The Federation feels that it has a strong and competent committee in the State of Massachusetts, and that the opportunities of this committee to be of public service to their own

state and in national engineering affairs is so great that the public-spirited engineers who have agreed to serve will be able to do much in putting the profession in its place as a recognized leader in civic affairs. This committee is headed by Prof. Comfort A. Adams of Harvard University. The other members of the committee are: John A. Stevens of Lowell; Charles R. Gow of Boston; Allen H. Rogers of Brookline; C. L. Newcomb of Holyoke; C. C. Chesney of Pittsfield, and E. E. Lochridge of Springfield.

The first important piece of work that was suggested for their consideration was support from the State of Massachusetts for a suitable topographic mapping program. This program, as most engineers know, is embodied in the Temple Bill which was before the last session of Congress, and provided authority for a program that would permit the United States Geological Survey to complete the mapping of the whole United States in a period of eighteen to twenty years, instead of approximately one hundred years which will be required at the present rate of progress. This bill affects in a more or less fundamental way practically every engineering project in the United States,—hydro-electric development, road construction, highway construction, railway building, river and harbor development, flood control, drainage engineering, city water supplies, canal building, prospecting for mines, geologic investigations, forestry work, land classification and valuation, education, aeronautics, and many other projects. While the State of Massachusetts has had its entire area mapped the majority of states have had only a small percentage of their area covered by such maps. According to the Geological Survey's records the mapping of Massachusetts was completed nearly twenty-five years ago, so that many of these maps are now badly out of date and inaccurate. It would be valuable to have new maps which would be absolutely modern and correct.

It will be recalled that after concerted effort on the part of the Federated American Engineering Societies and other interested organizations, the Federal appropriation for topographic mapping was raised from \$325 000 to \$500 000 for the next fiscal year. As a matter of fact the appropriation should

be nearly twice this amount to do the work most effectively and efficiently.

For a number of years the Federated American Engineering Societies and its predecessor, Engineering Council, has given continuous effort to its plan to establish a National Department of Public Works. It will be recalled by engineers that substantially the recommendations that they made for the establishment of such a Department were embodied in the report on Government Reorganization which was made by the President to Congress. This report contains the complete reorganization plan which has been arrived at as a result of many compromises by members of the Cabinet, and after a study by a special Congressional Committee which was headed by a special representative of the President.

Many engineering and civic organizations would readily recognize the advantages of such changes as are proposed in this Government re-organization plan and would be glad to confer with their representatives in Congress if they were advised of the conditions by engineers such as compose the Federation's State Administrative Committees. In addition to this many influential individuals would be willing to assist and practically every engineer would be glad to do his part in any dignified campaign that such a committee would direct.

The third important matter which has been laid before the State Administrative Committees for their consideration and support has been the proposed appropriation for a National Hydraulic Laboratory. The representatives of American Engineering Council have appeared before a Senate Committee in behalf of this measure, and the bill has already been favorably reported to the Senate by this committee. Such a measure, if passed, would enable engineers to have many of their river hydraulic problems solved without the use of the expensive "cut and try" method. Most of the other great developments in engineering have been based upon theoretical formulas derived from experimentation, but probably because of the size of the project no river hydraulic laboratories have been constructed.

In all of these important engineering matters which are now up for legislative consideration there is an opportunity for engineers to be of real public service in advising those in authority the value that would accrue to the country at large as a result of the consummation of these projects.

Thus, the Federation, through its State Administrative Committee in Massachusetts, appeals to the engineering organizations of the state, to the individual engineer, to civic organizations and to all influential citizens to weigh the facts and take such action as seems fitting and proper to secure action on this legislation because in so doing a great public service will be rendered.

MEMOIR OF DECEASED MEMBER.

CARL BICKNELL REED.*

THE untimely death of CARL BICKNELL REED, which was caused by a fall while performing his duties as Chemist at the Sewage Treatment Plant in Cleveland, Ohio, occurred on December 29, 1922.

He was born in South Weymouth, Mass., December 18, 1892, the son of George A. and Clara H. (Bates) Reed. He attended the public schools of Whitman, Mass., graduating from high school in 1909, where he was Salutatorian of his class, and receiving the gold medal given for "Highest General Excellency."

After graduating from high school and attending Bridge-water Normal School for one year he decided to go to college. He then went to work in a shoe factory and earned sufficient money to enable him to enter Worcester Polytechnic Institute in 1913, where he took a course in Sanitary Engineering, graduating in 1917. Here he was made a member of the Tau Beta Pi and Sigma Xi fraternities. He also received the Salisbury prize for high general efficiency.

After receiving his degree he accepted a position as Assistant Chemist with the New Hampshire State Board of Health at Concord, N. H. Remaining there about a year, he entered the employ of Metcalf & Eddy in March, 1918, as Chemist at the Wastes Treatment Plant of Winslow Bros. & Smith Co. in Norwood, Mass. He received a leave of absence in December, 1918, to enter the military service and was stationed at Camp Upton during the war. After his discharge from the army he resumed his duties at Norwood, continuing there until March, 1920, when he accepted a position with the city of Cleveland,

*Memoir prepared by Austin L. Maddox and Stuart E. Coburn.

Ohio, as Chemist and Bacteriologist of the Division of Sewage Disposal.

Mr. Reed was a member of the Methodist Church where he was particularly interested in the Baraca Class and the Young Peoples' Society. He was a 32nd degree Mason, and a member of the McKinley Chapter of Cleveland and the Temple Commandery of Norwood.

The shock of his death was all the more severe to his family and friends on account of its being followed on the next day by that of his father, who passed away in Fitchburg, after a lingering illness.

Mr. Reed leaves his mother and five sisters: Mrs. Helen R. Stanton, Mrs. Alta R. Underwood, Mrs. Beatrice R. Cobbs, Miss Bessie V. Reed and Miss Ruth B. Reed.

Mr. Reed was a young man of sterling worth, cheerful and conscientious, and a tireless worker. His early demise is a great loss to his many friends and associates.

BOSTON SOCIETY OF CIVIL ENGINEERSFOUNDED 1848

PROCEEDINGS

MINUTES OF MEETINGS.**BOSTON SOCIETY OF CIVIL ENGINEERS.**

BOSTON, May 16, 1923. — A regular meeting of the Boston Society of Civil Engineers was held this evening in Chipman Hall, Tremont Temple, and was called to order at 7.45 P.M., by the President, Frank M. Gunby. There were about 120 members and guests present.

The minutes of the previous meeting were approved as printed in the April JOURNAL.

The Secretary announced the names of those elected to membership by the Board of Government at meetings held on April 25, 1923, and May 16, 1923.

April 25, 1923. Members — Wallace E. Armstrong, Ray H. Lindgren, Bliss W. Robinson, Bernard M. Rivkin, Merritt P. Smith,* Clinton D. Thurber, and Edward P. Wells.*

May 16, 1923. Members — Albert George Martin,* and John Rule McLeish.

The Secretary presented a recommendation of the Board of Government that the regular June meeting be omitted, and that the Social Activities Committee be authorized to arrange for a June outing. It was voted to adopt this recommendation of the Board.

The President introduced Mr. A. A. Gathemann of the A. M. Byers Company of Pittsburgh, Pa., who spoke on "The

* Transferred from grade of Junior.

Manufacture of Genuine Wrought Iron Pipe," showing three reels of motion pictures illustrating the process of manufacture from the blast furnace to the shipment of the finished product.

After the presentation of the pictures, an informal discussion took place on the comparative uses of wrought-iron pipe and steel pipe for various purposes. During the course of the discussion Mr. Gathemann spoke at some length on corrosion, a subject with which he is very familiar from a long experience as engineer on vessels of the United States Navy. At the conclusion of what was one of the most interesting discussions of the year, the Society passed a vote of thanks to Mr. Gathemann for presenting the subject.

The meeting adjourned about 10 P.M.

J. B. BABCOCK, *Secretary*.

DESIGNERS SECTION.

BOSTON, May 9, 1923. — The regular May meeting of the Designers Section of the Boston Society of Civil Engineers was called to order in the Affiliation Rooms at 6.15 P.M., by Chairman Walter W. Clifford.

The report of the April meeting was read and approved.

The chairman introduced William F. Jones, Assistant Professor of Structural Geology at Massachusetts Institute of Technology, who spoke upon "Engineering Aspects of Geology."

Professor Jones brought out the importance of a thorough knowledge of the sites of certain projects such as dams, tunnels, etc.

An open discussion followed the talk. There were 31 members and visitors present.

The meeting adjourned at 7.30 P.M.

WALDO F. PIKE, *Clerk*.

NORTHEASTERN UNIVERSITY SECTION.

BOSTON, May 5, 1923. — The annual meeting of the Northeastern University Section of the Boston Society of Civil Engineers was called to order by Chairman D. C. Milne at 6.00 P.M., at the Affiliation Rooms, 715 Tremont Temple, Boston.

The chairman read the list submitted by the Nominating Committee, of nominations for officers for the ensuing year. Additional nominations were made from the floor.

The following officers were elected:

Chairman — Harold W. Kelly.

Vice-Chairman — Alfred O. Bradshaw.

Clerk — Fred W. Chase, Jr.

Executive Committee —

Roger G. Oakman,

William N. Parsons,

John B. Russell.

The Chairman then delivered a brief address on the review of the past year and submitted suggestions of benefit to the new officers.

In due appreciation of Chairman Milne's efficient work to make the year a success a rising vote of thanks was tendered by the Section.

Meeting adjourned at 7.15 P.M.

KARL H. AIMO, *Acting Clerk.*

APPLICATIONS FOR MEMBERSHIP.

[June 15, 1923.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or pro-

professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The facts that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

For Admission.

GARLAND, KIMBALL R., Brookline, Mass. (Age 33, b. Gloucester, Mass.) Graduate of Harvard College and Harvard Graduate School of Applied Science where he received degree in civil engineering. 1913-17 was employed by Hugh Nawn Contracting Co., on subway and bridge foundation construction; then went overseas with 101st Engineers until October 1918 and with the Depot Engineer Officer at St. Nazaire until September 1919. After returning to the United States was with Aberthaw Construction Company about five months, then joined the National Engineering Corporation as general engineer, estimator, schedule checker, etc. In September 1921, became the Boston representative of the Curtis Companies of Clinton, Ia., and in December 1922 entered the employ of Monks & Johnson as structural designer and is at present with them. Refers to W. H. Fowler, J. J. Harty, Hugh Nawn and J. R. Nichols.

GRANDE, VINCENZO JAMES, Boston, Mass. (Age 42, b. Italy.) Graduate of I. C. S. in steam, electrical and mechanical engineering. Has been in the contracting business since 1915, on bridges, sewers, water works, streets, etc. Is now doing general contracting. Refers to Joshua Atwood, J. E. Carty, J. M. McNulty and W. A. Woods.

HOOPER, OLCOTT LORIN, Cambridge, Mass. (Age 21, b. Chicago, Ill.) Student at Northwestern University, Evanston, Ill., from September 1918 to June 1921; student at Mass. Institute of Technology from September 1921 to June 1923. Was draftsman with the Bascule Bridge Co. from June to September 1922. Refers to J. B. Babcock, H. K. Barrows, A. G. Robbins, G. E. Russell, C. M. Spofford and H. Sutherland.

MCCANN, WILLIAM RAY, Newtonville, Mass. (Age 38, b. Paris, Ky.) Educated in the common and high schools of Chicago, Ill.; three years night school in electrical engineering at Lewis Institute, Chicago, and completed electrical engineering course at University of Wisconsin, graduating with master's degree. 1904-07, tracer, draftsman and checker with Commonwealth Edison Co., Chicago, Ill.; 1907-08, draftsman with Isthmian Canal Commission; 1908-10, student at University of Wisconsin; 1910-14, assistant engineer and supervisor of construction, Isthmian Canal Commission; 1914-15, student at University of Wisconsin doing graduate and thesis work leading

to electrical engineer's degree; 1915-17, private secretary and valuation engineer Public Utilities Commission, Springfield, Ill. 1917-18, with Emergency Fleet Corporation; 1918-19, assistant to president, Stenotype Co., Indianapolis, Ind; 1919 to date with Stone & Webster, Inc. Refers to J. B. Babcock, F. M. Gunby, D. C. Jackson, H. S. Knowlton, J. H. Manning and D. M. Wood.

ROONEY, GEORGE THOMAS, Somerville, Mass. (Age 32, b. Lynn, Mass.) Graduate of Mass. Institute Technolgy. Was engineer on East River Tunnels, January 1916 to May 1917; three months as construction engineer, Atlantic Refining Co.; assistant resident engineer, July 1917 to August 1918, H. L. Cooper Co.; superintendent U. S. Housing Corporation, August 1918 to August 1919; field engineer, H. L. Cooper Co., August 1919 to May 1920; construction engineer, The Scully Co., May 1920 to date. Refers to S. R. Berke, W. F. Pike, F. P. Scully, H. C. Sheils, H. C. Thomas and J. F. Travers.

LIST OF MEMBERS.

ADDITIONS.

ARCHIBALD, WHITTEMORE C..... 211 Lexington St., Waltham, Mass.
 McLEISH, JOHN R..... 10 Aspen St., Roxbury, Mass.
 RIVKIN, BERNARD M..... 51 North St., Pittsfield, Mass.

CHANGES OF ADDRESS.

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 BURRAGE, HENRY T..... 314 E. Upsal St., Philadelphia, Pa.
 CASEY, JOHN J..... 36 Bartlett Ave., Arlington, Mass.
 CHEVALIER, CHARLES R..... 201 Prospect St., Woodfords, Me.
 FULLER, WILLIAM B..... 219 So. Central Ave., Eagle Rock, Cal.
 GAGE, ELLIOT H..... P. O. Box 173, Badin, N. C.
 MARNELL, HAROLD F..... 1774 Columbia Road, So. Boston, Mass.
 MILDRAH, HENRY C..... 635 Tremont Bldg., Boston, Mass.
 REED, ALONZO B..... 88 Broad St., Rm. 620, Boston, Mass.
 STEVENS, FRANK B., JR..... 1235 Collinwood, Detroit, Mich.
 THORON, BENJAMIN W..... 1741 K St., Washington, D. C.
 WHITMAN, RALPH..... Commander, C. E. C., U. S. Navy, Bureau of Yards
 and Docks, Navy Dept., Washington, D. C.
 YOUNG, ERVING M..... 55 Van Rerpen Ave., Jersey City, N. J.

DEATH.

HERING, RUDOLPH May 30, 1923

LIBRARY NOTES.**RECENT ADDITIONS TO THE LIBRARY.****U. S. Government Reports.**

Reconnaissance and Signal Building. Department of Commerce.

Use of Geodetic Control for City Surveys. Department of Commerce.

Water Supply Papers, Nos. 488 and 493.

State Reports.

Massachusetts. Annual Report of Department of Public Works, Division of Highways. 1921.

County Reports.

Essex County. Annual Report. 1922.

Municipal Reports.

Boston, Mass. Annual Report Finance Commission. 1922.

Concord, N. H. Annual Report Board of Water Commissioners. 1922.

Danvers, Mass. Annual Report Water Commissioners, 1922.

Dover, N. H. Annual Report Board of Water Commissioners. 1922.

Fall River, Mass. Annual Report City Engineer. 1922.

New York, N. Y. Annual Report President, Borough of Manhattan. 1922.

Providence, R. I. Annual Report Department of Public Works. 1922.

Wellesley, Mass. Annual Report Water and Municipal Light Commissioners. 1922.

Miscellaneous.

Nipigon Hydro-Electric Power Development. Toronto. 1922.

LIBRARY COMMITTEE.

BOSTON SOCIETY OF CIVIL ENGINEERS

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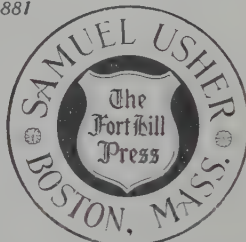
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